AD-A061 870 ARMAMENT DEVELOPMENT AND TEST CENTER EGLIN AFB FLA F/G 14/2

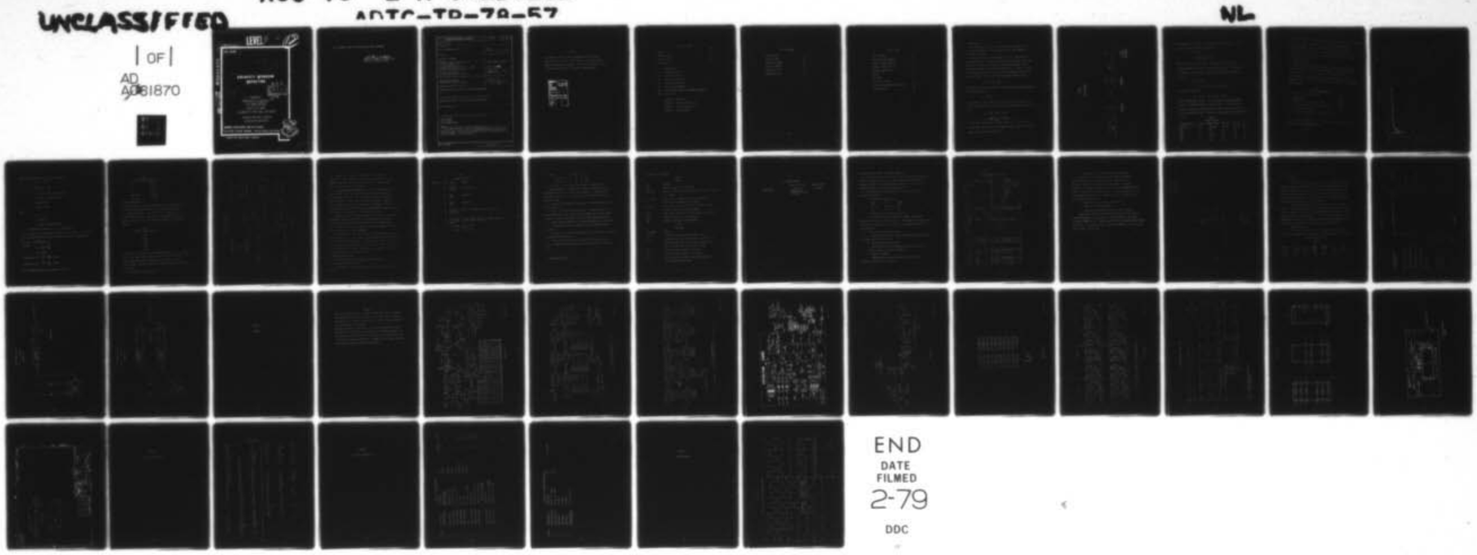
VELOCITY WINDOW DETECTOR.(U)

AUG 78 L R CALDWELL

UNCLASSIFIED ADTC-TR-78-57 NL

1 OF 1

AD A061870

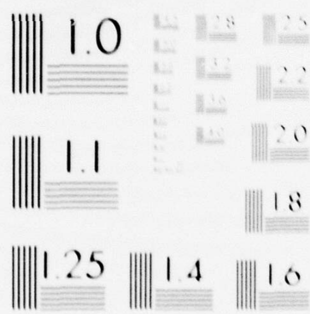


END

DATE FILMED

2-79

DDC



MICROCOPY RESOLUTION TEST CHART

LEVEL II

ADTC-TR-78-57

FINAL REPORT

11 Aug 78

12 47p.

VELOCITY WINDOW DETECTOR

16 9993

PREPARED BY

MAJOR LAPSLEY R. CALDWELL
TEST TRACK DIVISION
6535TH TEST GROUP
HOLLOMAN AIR FORCE BASE, NEW MEXICO

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

ARMAMENT DEVELOPMENT AND TEST CENTER

AIR FORCE SYSTEMS COMMAND - UNITED STATES AIR FORCE

EGLIN AIR FORCE BASE, FLORIDA

THIS TECHNICAL REPORT HAS BEEN REVIEWED AND IS APPROVED.

Wallace B. Adam

WALLACE B. ADAM, Lt Colonel, USAF
Chief, Test Track Division

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER ADTC-TR-78-57	2. GOVT ACCESSION NO.
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Velocity Window Detector	5. TYPE OF REPORT & PERIOD COVERED Final
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Lapsley R. Caldwell	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS 6585 Test Group (AFSC) Test Track Division (TKI) Holloman AFB, New Mexico 88330	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS JON: 99930000
11. CONTROLLING OFFICE NAME AND ADDRESS 6585 Test Group (AFSC) Holloman AFB, New Mexico 88330	12. REPORT DATE August 1978
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 6585 Test Group (AFSC) Holloman AFB, New Mexico 88330	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Approved for public release; distribution unlimited.

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Rocket Sleds
Track Testing
Velocity Measurement

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes a velocity window detector that senses that the velocity of a test item is within a specified tolerance, (hence the name velocity window). If the velocity window criteria is satisfied then the detector initiates a desired event.

DD FORM 1 JAN 73 1473

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ABSTRACT

This report describes a velocity window detector that senses that the velocity of a test item is within a specified tolerance, (hence the name velocity window). If the velocity window criteria is satisfied then the detector initiates a desired event.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION:

This report describes a velocity window detector designed for use at the AF High Speed Test Track, Holloman Air Force Base, New Mexico.

II. GENERAL DISCUSSION:

The purpose of the velocity window detector is to sense that a test item, usually a sled, is moving at a desired velocity within a specified tolerance, (hence the name window). If the velocity window criteria is met then the detector initiates a desired event. As shown in Figure I, the sled passes track station 1, (S_1), at time T_1 and next passes track station 2, (S_2), at time T_2. The average velocity between S_1 and S_2 is:

$$V_{12} = \frac{S_2 - S_1}{T_2 - T_1} = \frac{S_{12}}{T_{12}}$$

The time, (T_{12}), that is required for the sled to travel from track station 1 to track station 2, is:

$$T_{12} = \frac{S_{12}}{V_{12}}$$

As an example, if track station 1 is at 6850 ft, track station 2 is at 6950 ft, track station 3 is 7000 ft and the average velocity is 1000 ft/sec then:

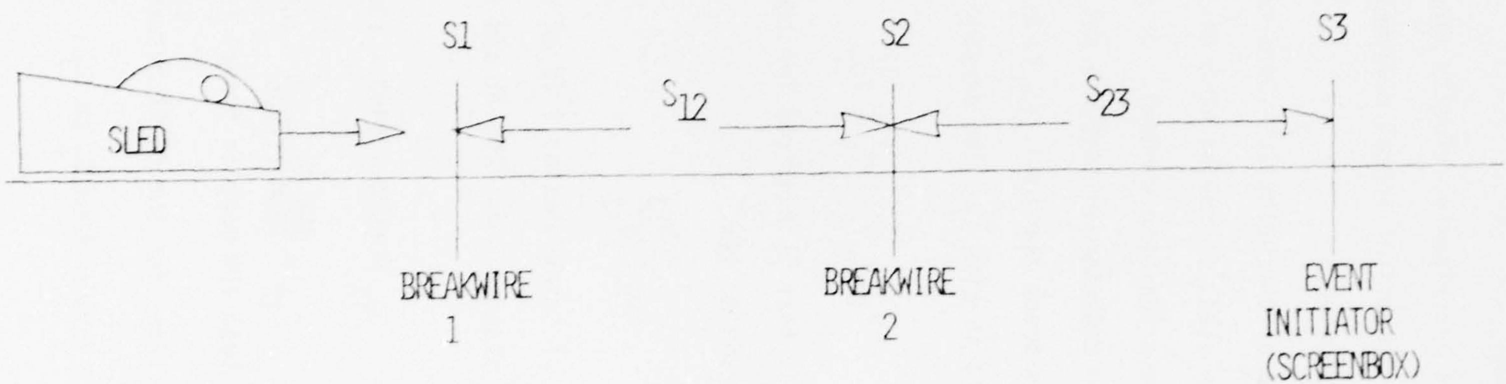
$$S_{12} = 6950 - 6850 = 100 \text{ ft}$$

$$T_{12} = \frac{100 \text{ ft}}{1000 \text{ ft/sec}} = 100 \text{ msec}$$

The sled would take 100 msec to travel from S_1 to S_2. If the velocity remained 1000 ft/sec for the 50 ft between S_2 and S_3 then the sled would take 50 msec to travel from S_2 to S_3.

FIGURE I

TRACK STATIONS



If the velocity is not equal to the desired velocity V_{12}', but is instead equal to K times the desired velocity then:

$$V_{12} = KV_{12}'$$

$$T_{12} = \frac{S_{12}}{V_{12}} = \frac{S_{12}}{KV_{12}'} = \frac{1}{K} T_{12}'$$

Where T_{12} is the actual time, V_{12}' is the desired velocity and T_{12}' is the expected travel time at the desired velocity V_{12}'. As an example if S_1 is 6850 ft, S_2 is 6950 ft, S_3 7000 ft, V_{12}' is 1000 ft/sec and V_{12} is 10% low:

$$V_{12} = .90\ V_{12}'$$

$$T_{12} = \frac{1}{.9} T_{12}' = \frac{1}{.9} (100 \text{ ms}) = 111.1 \text{ msec}$$

if V_{12} was 10% high, then:

$$T_{12} = \frac{1}{1.1} T_{12}' = \frac{1}{1.1} (100 \text{ ms}) = 90.91 \text{ ms}$$

Table 1 shows several examples. In each example the distance between S_1 and S_2 is 100 ft and between S_2 and S_3 is 50 ft. The high velocity results in a low time, (window start time), the low velocity results in a high time (window stop time). Window times are rounded to the nearest millisecond.

TABLE 1

Typical Examples

DESIRED VELOCITY	+% ERROR	NOMINAL TIME	START TIME	STOP TIME	T_{23}
1000 ft/sec	10%	100 msec	91 msec	111 msec	50 ms
1000	5	100	95	105	50
1200	10	83.33	76	93	42
1200	5	83.33	79	88	42
800	10	125	114	139	63
800	5	125	119	132	63

T_{23} is the nominal time required for the sled to travel from S_2 to S_3 when the event is initiated. These calculations assume the nominal velocity continues between S_2 and S_3. This time must be greater than the time delay that is required to arm the event initiator. For an ejection test using a screen box power supply this time should be equal to or greater than 50 milliseconds.

III. PARAMETER SELECTION:

The previous section discussed the general theory of what the velocity window detector does, and how the window parameters are used to determine velocity performance. This section will describe how the velocity window parameters are calculated, given certain desired mission performance. The data in Table 2 and Figure II will be used as an example for calculating window parameters.

TABLE 2

TYPICAL MISSION PARAMETERS

Event Initiation Track Station	7000 ft
Launch Point	5929 ft
Distance of Event from Launch Point	1071 ft
Velocity at 1071 from Launch Point (Fig II)	456 ft/sec
Velocity Window in Percent	$\pm 10\%$

A. Since the event must be at track station 7000:

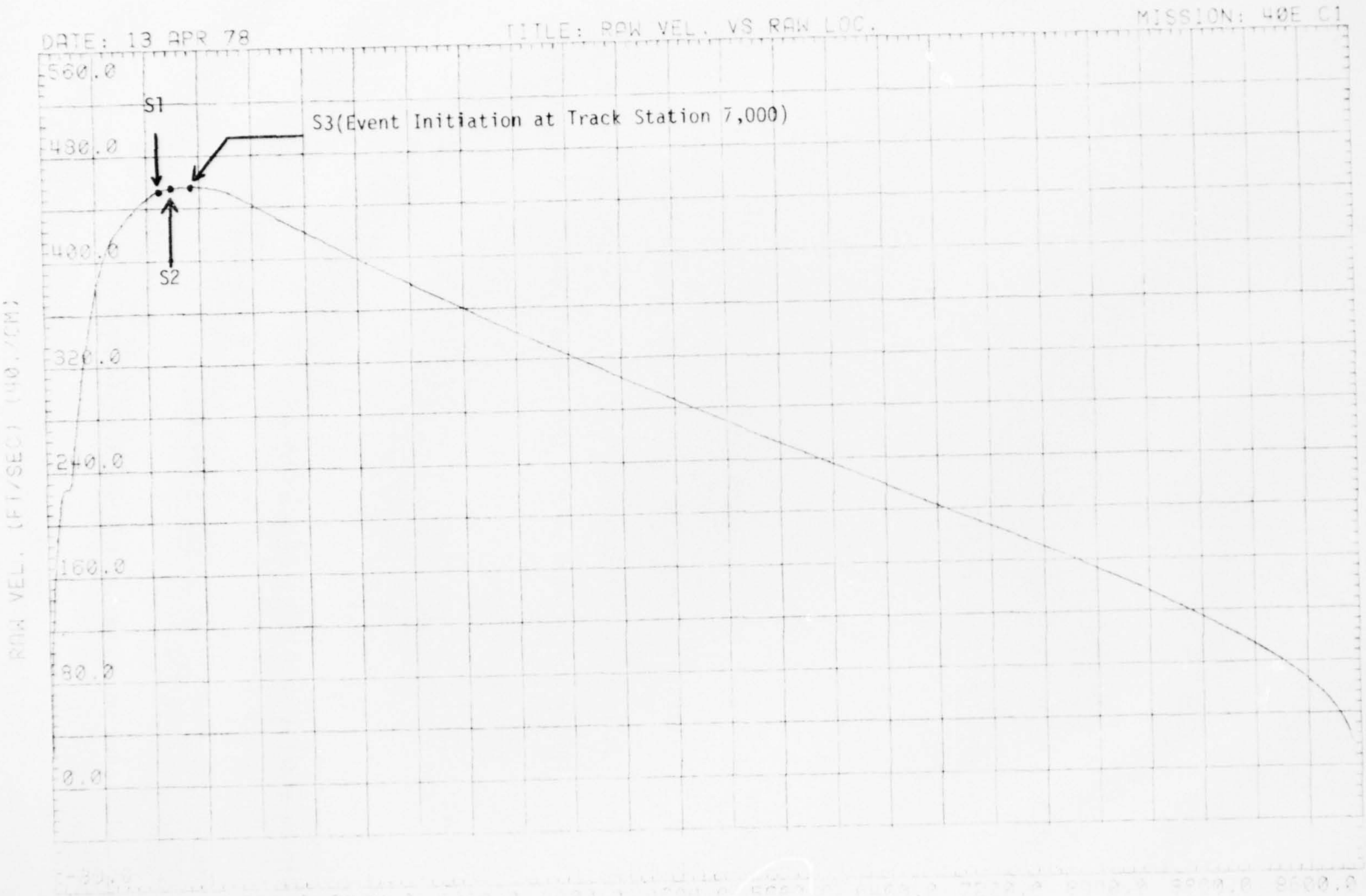
$$S_3 = 7000$$

B. S_2 must be chosen such that $T_{23} \geq 50$ ms. We will assume that the velocity is constant between S_2 and S_3:

$$V_{23}' = 456$$

FIGURE II

VELOCITY PROFILE



Minimum time corresponds to max velocity therefore:

$$V_{23} = 1.10\, V_{23}'$$

$$50 \text{ ms} \leq T_{23} = \frac{S_{23}}{V_{23}}$$

$$S_{23} \geq 50 \text{ ms } (V_{23}) = 50 \text{ ms } (1.1\, V_{23}')$$

$$S_{23} \geq 50 \text{ ms } (1.1)(456 \text{ ft/sec})$$

$$S_{23} \geq 25.08 \text{ ft}$$

$$\text{let } S_{23} = 30 \text{ ft}$$

then

$$S_2 = S_3 - S_{23}$$

$$S_2 = 7000 - 30$$

$$S_2 = 6970 \text{ ft (track station)}$$

C. S_1 is arbitrarily chosen as $S_1 = S_2 - 100 = 6870$ ft

D. From the listing corresponding to Figure II we see that at 30 to 130 ft, (S_2 to S_1), before the desired event, the nominal velocity is approximately 454 ft/sec. The window times are:

Nominal:

$$T_{12}' = \frac{S_{12}}{V_{12}'} = \frac{100}{454}$$

$$T_{12}' = 220 \text{ ms}$$

$$\text{Window start time} = \frac{T_{12}'}{K} = \frac{220}{1.10} = 200 \text{ ms}$$

$$\text{Window stop time} = \frac{T_{12}'}{K} = \frac{220}{.90} = 244 \text{ ms}$$

These calculated parameters are summarized in Table 3.

TABLE 3

VELOCITY WINDOW PARAMETERS

S1	7000 ft
S2	6970 ft
S3	6870 ft
Start time	200 msec
Stop time	244 msec

IV. FUNCTIONAL DESCRIPTION:

A block diagram of the velocity window detector is shown in Figure III. Signal names corresponding to the circuit are shown in parenthesis.

A. Phase Locked Clock: The internal clock is phase locked to an external reference source. The external source may be GT,* IRIG, or a square wave, at any nominal rate specified in Table 4, as selected on switch S_1.

TABLE 4

EXTERNAL TIMING CODE RATES

50 kHz
20 kHz
10 kHz
5 kHz
2 kHz

The phase lock clock will track the external reference but if the external clock is lost, the internal clock will rapidly drift off frequency. The input is transformer coupled, permitting the external signal to be either polarity. The input signal level should be between 2 and 20 volts peak to peak.

* GT is an internal Track time code.

VELOCITY WINDOW DETECTOR

FUNCTIONAL DIAGRAM

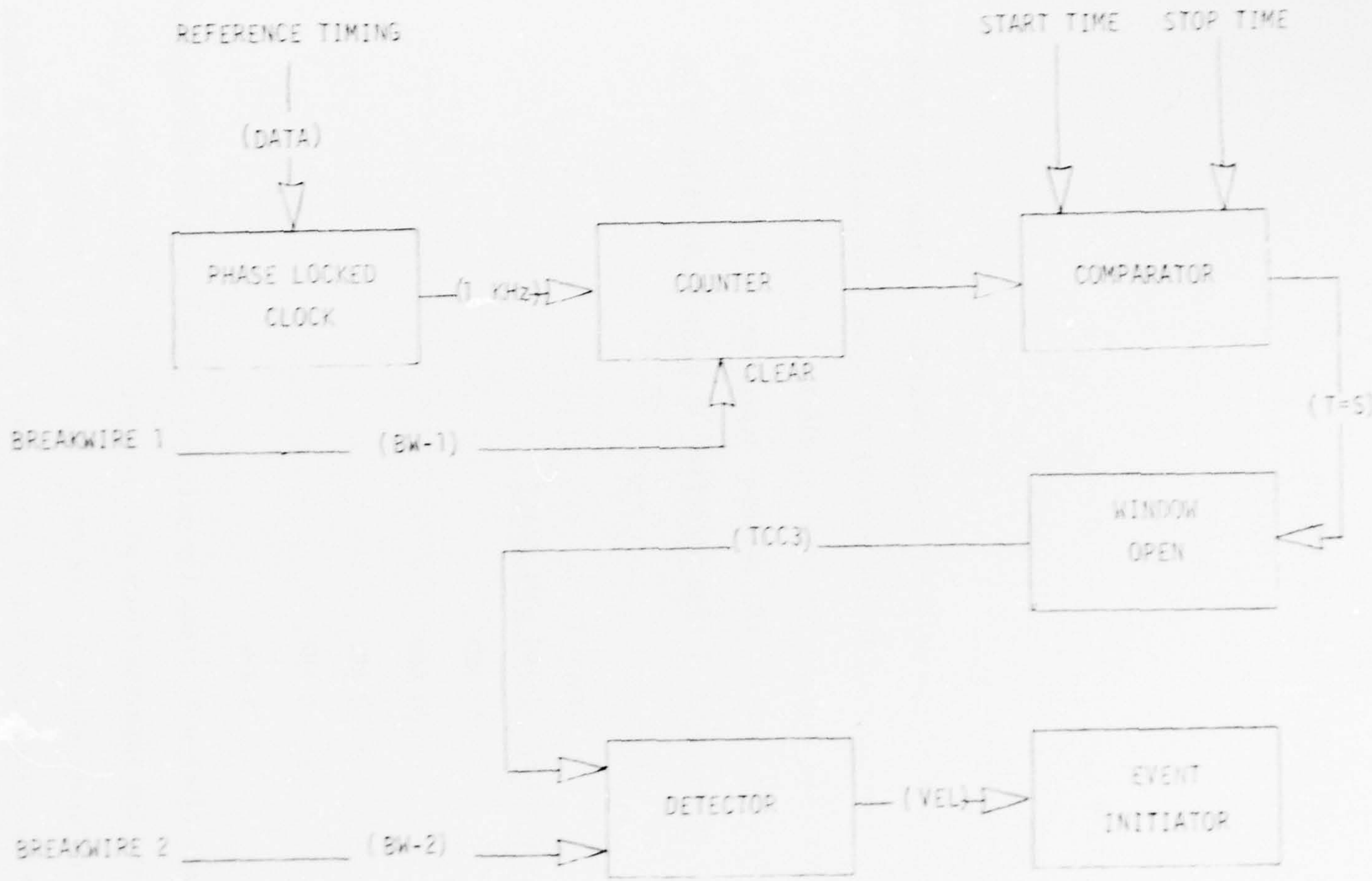


FIGURE III

B. Counter: The counter is cleared each millisecond or until breakwire 1 is broken. When the sled reaches track station S_1 it opens breakwire 1 and the counter starts counting up at a 1 KHZ rate (which results in a one millisecond resolution).

C. Comparator: Before the window start time, the comparator checks the counter contents against the start time switch setting. When they are equal the window is opened. After the window is opened the comparator checks the counter contents against the stop time switches. When the counter contents equals the stop time switches the window is closed. It should be noted that with this technique the window may be opened indefinitely by selecting a stop time that is less than the start time.

C. Detector: If the sled opens breakwire 2 at track station S_2 while the window is open then the detector will activate the event initiator. The event initiator will remain activated until the velocity window is reset. If the sled does not cut breakwire 2 while the window is open then the event initiator will not be activated.

D. Event Initiator: The event initiator is a high voltage power supply at track station S_3. The high voltage is armed through a relay controlled by a second relay in the detector. Time delays, under nominal conditions, in the two relays and trackside cable are 10 to 20 milliseconds. Therefore, the time required for the sled to move from S_2 to S_3 should be in excess of 50 milliseconds to insure proper arming.

V. OPERATING INSTRUCTIONS:

A. Insure that cables are connected as shown in Table 5.

B. Set code rate to 2, (2KHZ).

C. Turn power on. The power indicator and the data indicator should turn on.

TABLE 5

EXTERNAL CONNECTIONS

CONNECTOR	PIN	SIGNAL	REMARKS
J1			
	A	115 VAC	
	B	Ground	Chassis ground
	C	115 VAC	
J2			
	A	BW2 L	Breakwire 2
	B	BW2 H	
J3			
	A	BW1 L	Breakwire 1
	B	BW1 H	
J4			
	A	Relay arm	Contact close when event initiation occurs.
	B	N.O. contact	
	E	Ground	
J5			
	A	Ext timing	External timing, 2-20 volts, either polarity,
	B	Ext timing	*(usually 2KHZ GT timing)*
	C	Ground	
J6		Ext timing	Same as J5 A.
J7		Ext timing	Same as J5 B.

D. Set:

		HR	MIN	SEC	MS
Start time	=	00	00	09	696
Stop time	=	00	00	16	969

E. Push reset. LED* indicators BW1, BW2 and VEL should be off.

F. Open breakwire #1. Immediately LED indicator BW1 should light. Approximately 13 seconds after BW1, open breakwire 2. Both indicators BW2 and VEL should go on. The trackside screen box should be armed and hot at this time.

G. Reconnect both breakwire and push reset. Indicators BW1, BW2, and VEL should go off.

H. Steps F and G should be repeated twice. Once BW2 should be opened before 9.696 seconds, and once BW2 should be opened after 16.969 seconds, in each case indicator BW2 should turn on, but VEL should not turn on.

I. Insure that both breakwires are properly reconnected and installed.

J. Set the mission velocity window start time and velocity window stop time.

K. Push reset. The velocity window detector is now ready and indicators BW1, BW2 and VEL should be off.

L. After the mission the indicators should show if BW1 and BW2 were broken. If BW2 occurred between the start and stop times then VEL should be on.

* Light emitting diode

VI. SWITCHES AND INDICATORS:

TABLE 6

SWITCHES

SWITCH	FUNCTION
Power	Applies AC power to all circuitry.
Code Rate	Selects desired timing code rate (normally set to 2 for 2KHZ G.T. timing).
Start time	Selects desired window start time with respect to BW1 opening, to activate velocity window.
Stop time	Selects desired window stop time, with respect to BW1 opening, to deactivate velocity window.
Reset	Resets relay control and velocity window timing circuits.
SBW1	Simulates opening of first breakwire.
SBW2	Simulates opening of second breakwire.

TABLE 7

INDICATORS

INDICATORS	FUNCTION
Power	On indicates the internal power supply is on.
Data	On indicates that an external signal is applied to the external timing input. It does not indicate that the clock is phased locked to the external signal.
BW1	On indicates that breakwire 1 was broken.
BW2	On indicates that breakwire 2 was broken.
VEL	On indicates that breakwire 2 was broken between the start time and the stop time.

TABLE 8

TEST POINT VOLTAGES

	Breakwire Shorted	Breakwire Open
TP1 to TP2 (TP3 to TP4)	2.4-3.3 volts (Depends upon breakwire resistance up to 200Ω)	8.0 volts

VII. MODIFICATIONS TO MODEL 9800 CAMERA CONTROLLER:

The velocity window detector is a modified model 9800 camera controller (DATUM, part number 9800-610). This section describes the modifications necessary to convert the model 9800 camera controller for use either as a camera controller or as a velocity window detector.

A. The following wiring modifications to the model 9800 camera controller are required:

1. Remove the following wires:

FROM	TO	SIGNAL
Pin 12 C1	Pin 10 C9	$\overline{\text{Fwd}}$
E25	Pin 1 D 7	TCC3

2. Add the wires to J102 shown in Table 8.

3. On the LED Driver Card (DATUM, part number 16160) jumper plug P102 pin 6 to pin 8 and pin 5 to pin 7. These jumper wires added to the LED Driver Card replaces the wires removed in 1 above when the LED Driver Card is inserted.

B. To use as a velocity window detector:

1. Remove D4 (SN74107) and replace with jumper plug D4 substitute. (This holds STB1 and STB2 at a zero).

2. Add front panel for rack mount.

3. Remove LED Driver Card and replace with the detector card.

C. To use as a model 9800 camera controller:

1. Remove front panel.

2. Remove detector card and replace with LED Driver Card, (modified as discussed in A.4. above).

TABLE 9

VELOCITY WINDOW MODIFICATIONS
(J102 Pins)

	PRESENT	ADD	REMARKS
1		+5V	+5V (+5 volts pwr)
2		+5V	+5V (+5 volts pwr)
3		E15	Reset
4		10C1	200KHZ
5		10C9	Fwd
6		9D6	TCC3
7		12C1	Zero
8		1D7	Vel
9			
10	TP1, J3B	No change	BW1H(Breakwire 1 hi)
11			
12			
13			
14	Ground	No change	Gnd (pwr ground)
15			
16			
17			
18			
19			
20			
21	TP2, TP4	No change	GND (signal ground)
22	TP3, J2B	No change	BW2H(Breakwire 2 hi)
23			
24			
25	J2A	No change	BW2L(Breakwire 2 low)
26	R2-CT	No change	Not used
27			
28	J3A	No change	BW1L(Breakwire 1 low)
29	R1-CT	No change	Not used
30	+8V	No change	+8V (+8 volts)

3. Remove jumper plug in D4 and replace with SN74107.

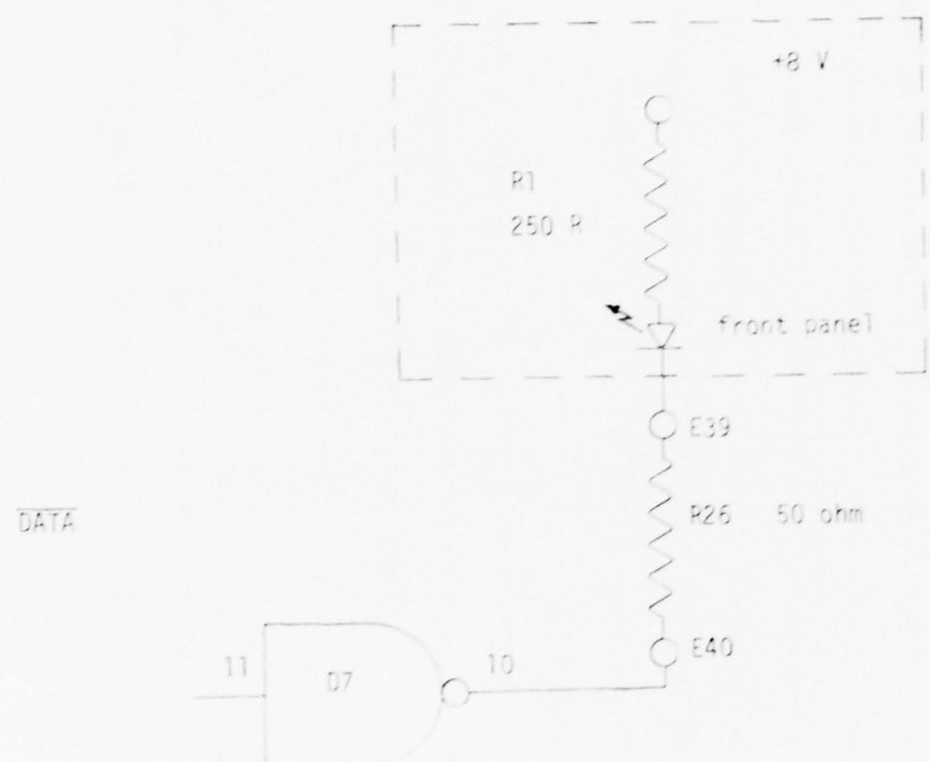
C. As an operator aid an indicator can be added to show that external time pulses are present at the camera controller. This modification adds an LED indicator to the Datum Model 7800 camera controller. The purpose of the LED is to provide an indication that pulse timing is arriving at the camera controller. The DATA indicator does not indicate that the internal clock is phase locked to the external timing. This modification consists of:

1. Replace R26 (150 ohm) with a 50 ohm resistor.
2. Mount a LED on the front panel.
3. Insert the LED between R1 and R26 as shown in Figure IV.

When external timing is present the pulse train will pass through steering diodes CR1 (or CR2) capacitor C1 and transformer T1 and switch the output, ($\overline{\text{DATA}}$), of F5. This will cause D7 pin 10 to switch current through the LED (DS5). If external timing is not present $\overline{\text{DATA}}$ will be a zero and the output D7 pin 10 will be high.

MODIFICATIONS

1. Replace R26
2. Add LED as shown



DATA LED INDICATOR

FIGURE IV

VIII. TEST RESULTS:

A. Time Delays:

Of particular concern for the velocity window is the time delay between the time (T_2) that breakwire 2 is broken and the time that the event initiator (screenbox) is activated. The control signal that energizes the screenbox must pass through two relays, the first relay in the velocity window controls the second relay (trackside in the screenbox power supply) that applies the high voltage to the screenbox.

In order to measure a worst case delay the circuit of Figure V was used. The velocity window control signal was routed from the Track Data Center to FOX 90, 2 and looped to a screenbox power supply back to a screenbox power supply at the Track Data Center. The total length of cable was approximately 36,000 feet. The measured time delay between breakwire 2 and voltage on the screenbox power supply output was 13 milliseconds.

B. Operational Tests:

The velocity window was tested on several active sled tests. The test setup is shown in Figure VI and test results are summarized in Table 10.

OPERATIONAL TEST RESULTS

TABLE 10

MISSION	S_{12}	S_{23}	START TIME	STOP TIME	T_{12}	T_{23}
6P-J2A	100 ft	50 ft	96 ms	117 ms	113 ms	83 ms
42G-A3A	150 ft	50 ft	81 ms	98 ms	91 ms	

TIME DELAY TESTS

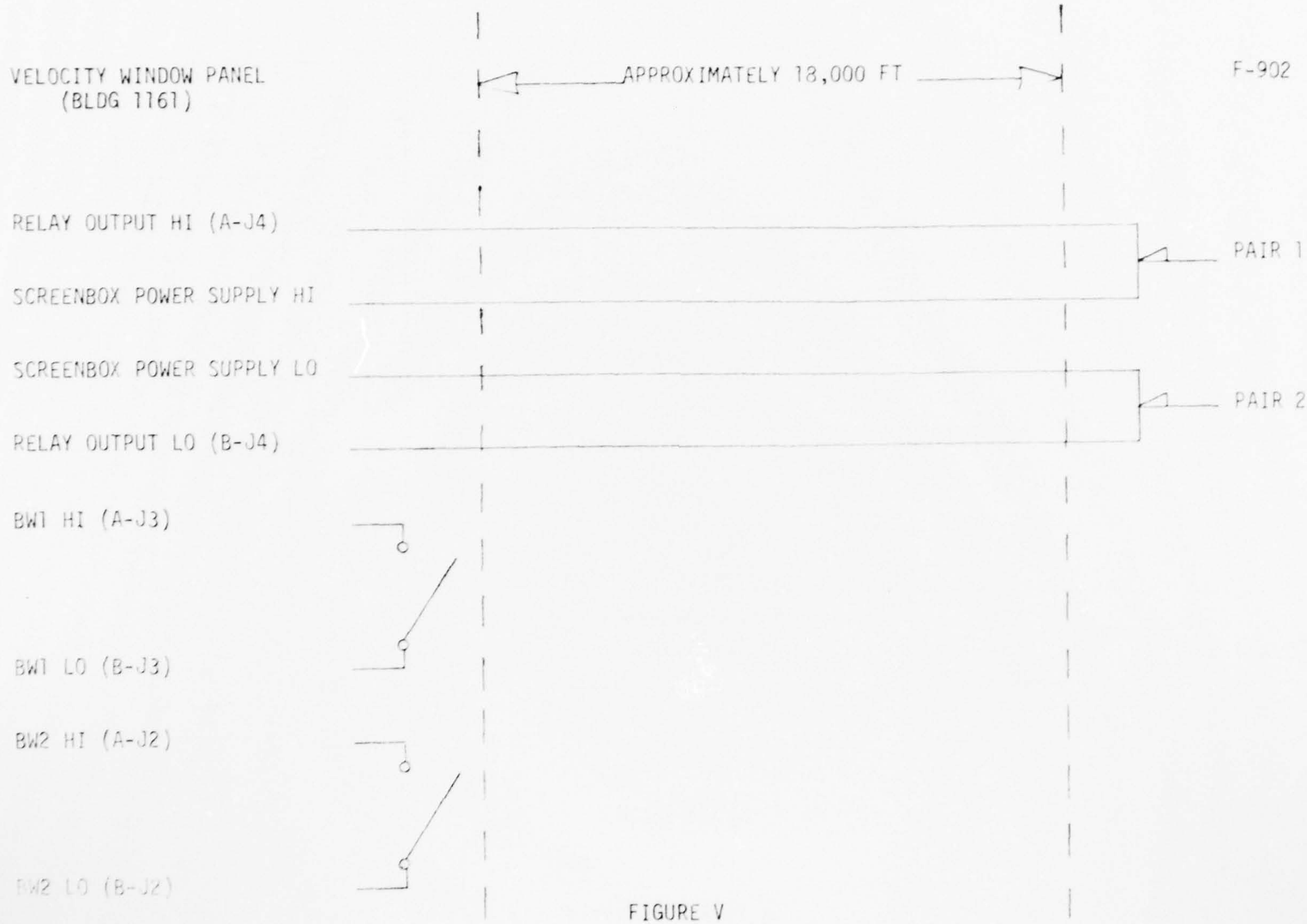
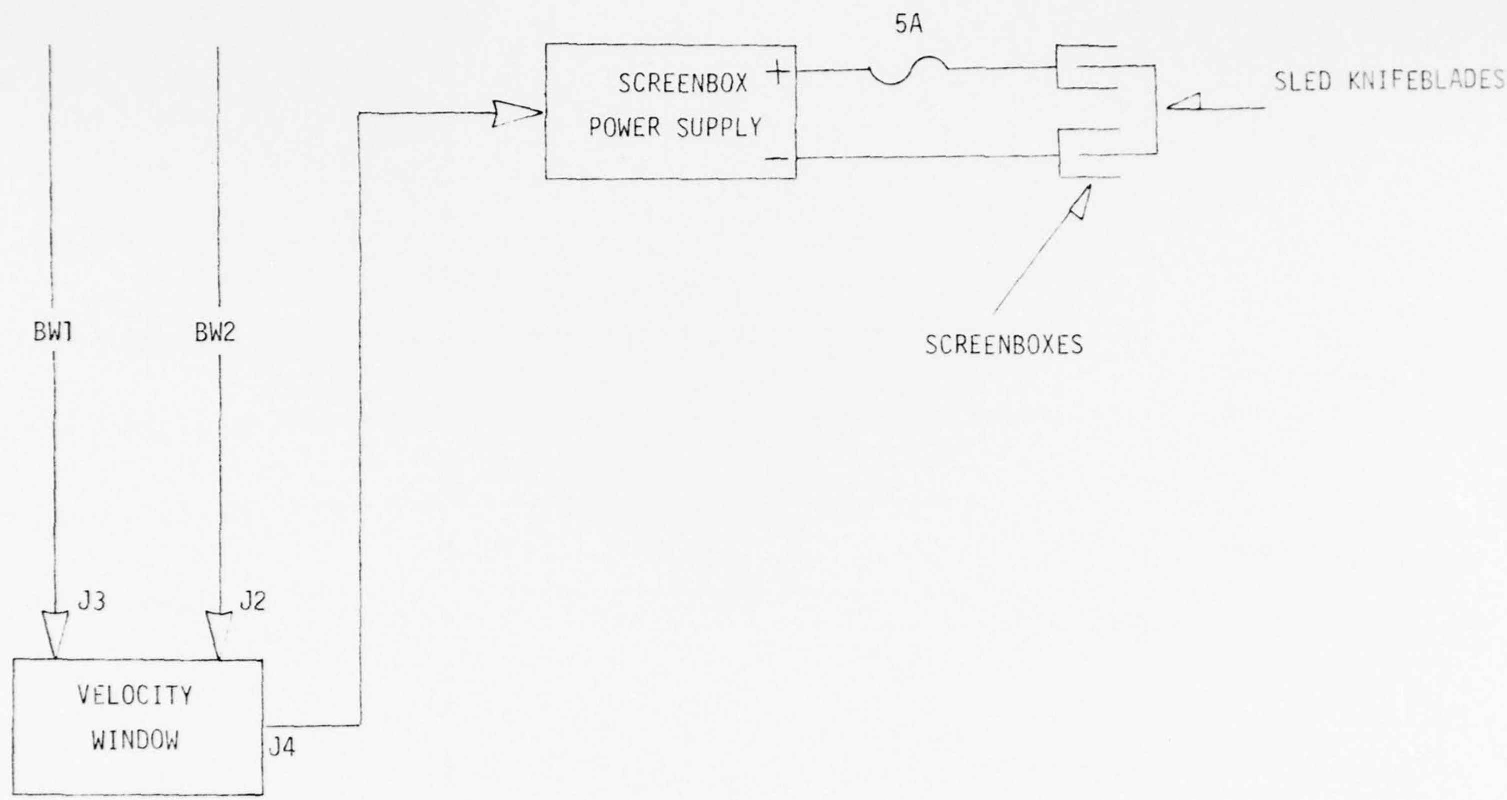


FIGURE V

OPERATIONAL TEST #1

6P 23 JUN 78

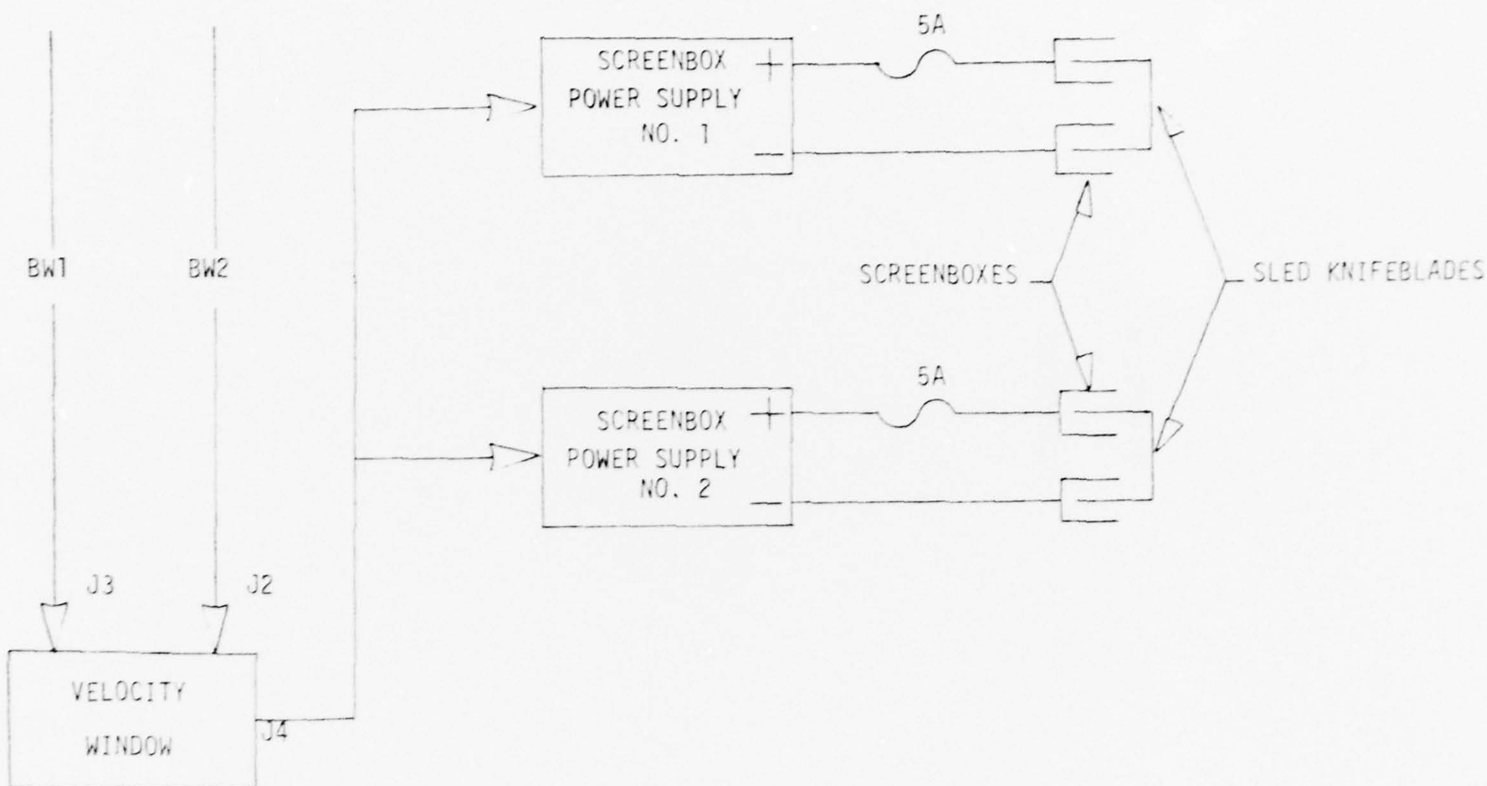
FIGURE VI A



OPERATIONAL TEST #2

42G   12 JUL 78

FIGURE VI B



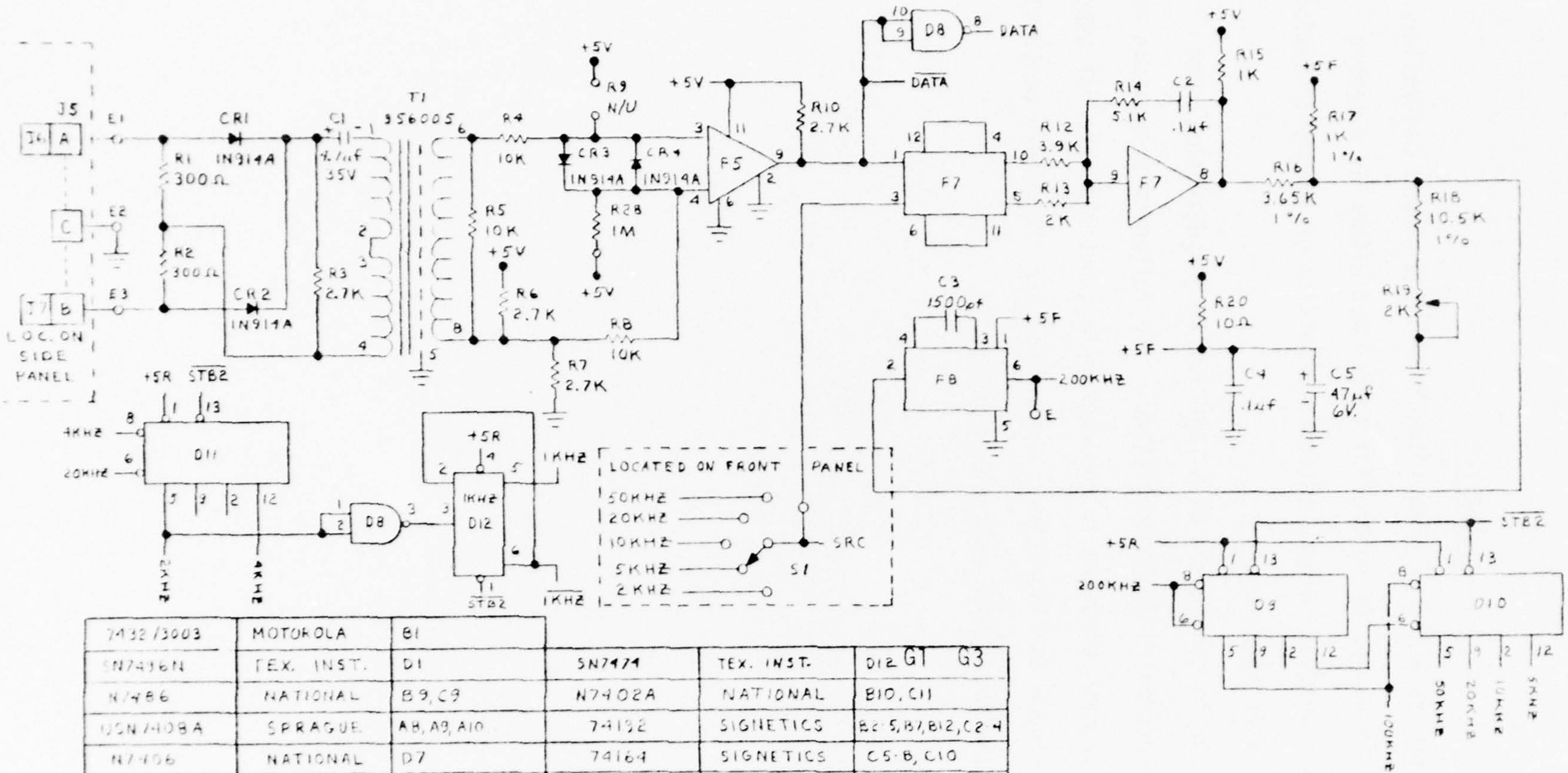
APPENDIX A

SCHEMATICS

SCHEMATICS

The velocity window detector is a modified Model 9800 camera controller. These modifications allow the controller to be used either as a camera controller or as a velocity window detector. Details of the modifications are in Section VII of this report.

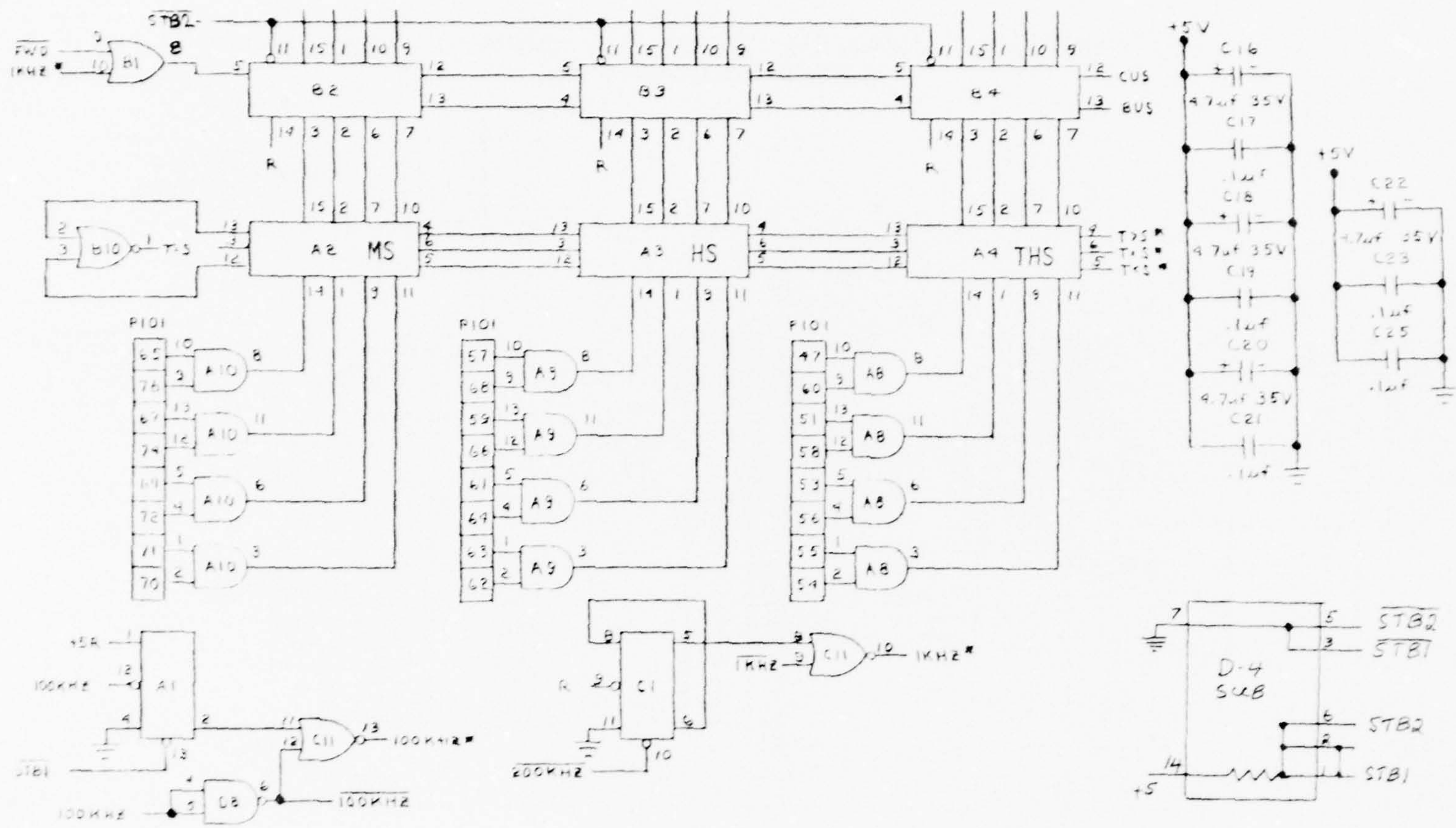
When the controller is configured as a velocity window detector, some of the controller electronics are not utilized. The following schematics do not reflect electronics that are in the controller, but that are not used in the velocity window configuration. Schematics for the camera controller are provided in the Model 9800 controller manual.



7432/3003	MOTOROLA	B1			
SN7496N	TEX. INST.	D1	SN7474	TEX. INST.	D12 G1 G3
N7486	NATIONAL	B9, C9	N7402A	NATIONAL	B10, C11
USN7408A	SPRAGUE	A8, A9, A10	74132	SIGNETICS	B2-5, B7, B12, C2-4
N7406	NATIONAL	D7	74164	SIGNETICS	C5-8, C10
N7400A	NATIONAL	B8, C12, D5, D8 G2	74185	SIGNETICS	A2-7, A11, A12
SN74107	TEX. INST.	A1, C1, D4	N8288A	SIGNETICS	B6, B11
SN74H103N	TEX. INST.	D6	LM311D	NATIONAL	F5
MC4044P	MOTOROLA	F7	N8281A	SIGNETICS	D2, D3, D10
MC4024P	MOTOROLA	F8	N8280A	SIGNETICS	D9, D11
PART NO	MFR	REF	PART NO	MFR	REF

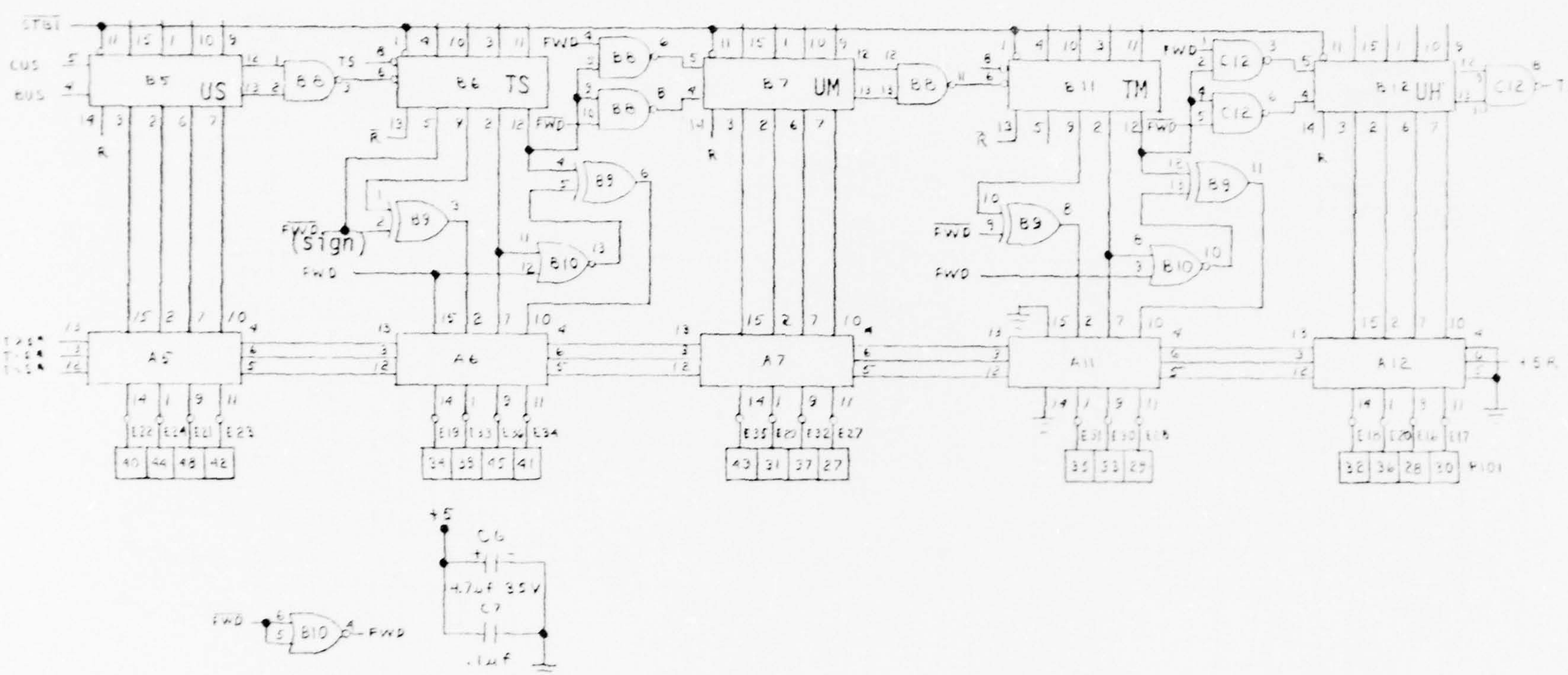
INPUT & VCO

Sheet 1 of 5



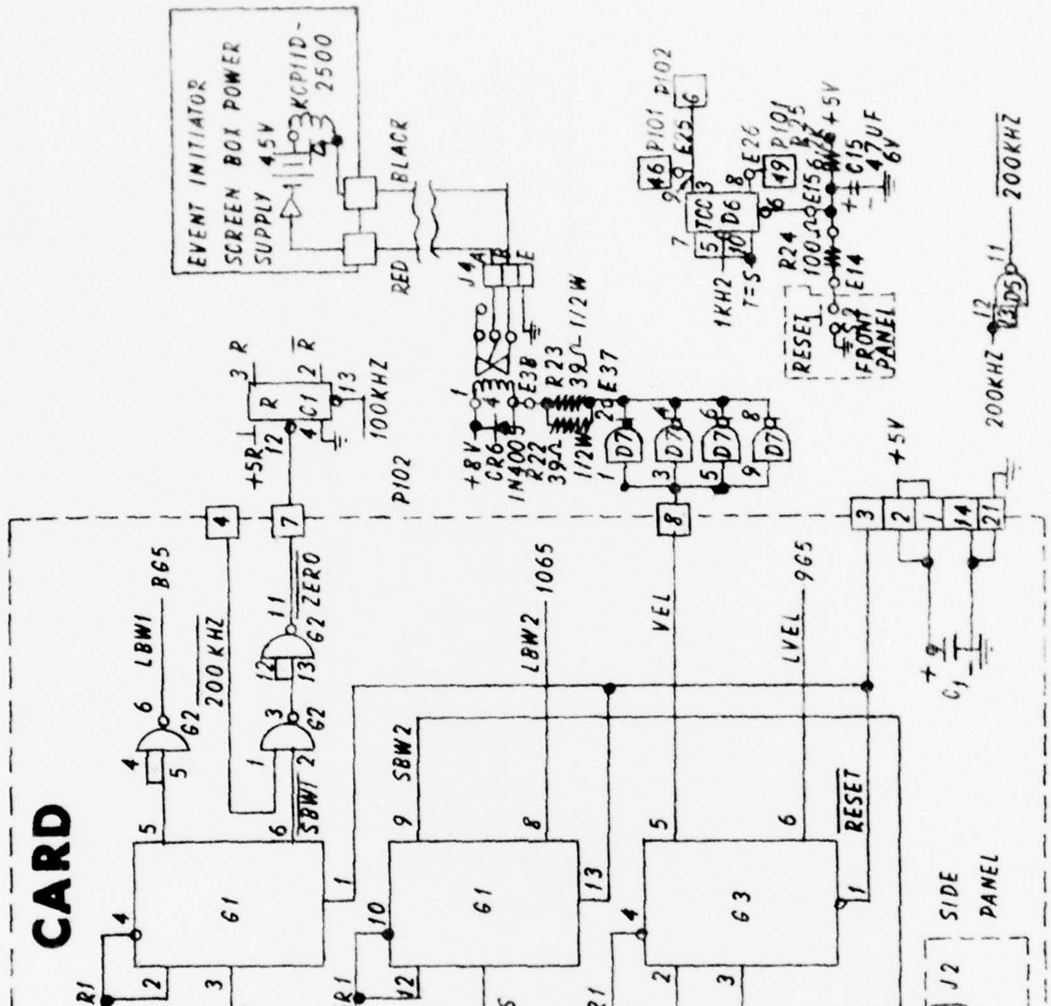
MINOR COUNTER/COMPARATOR
(MILLISECOND, HUNDREDTH SECOND, TENTH SECOND)

Sheet 2 of 5

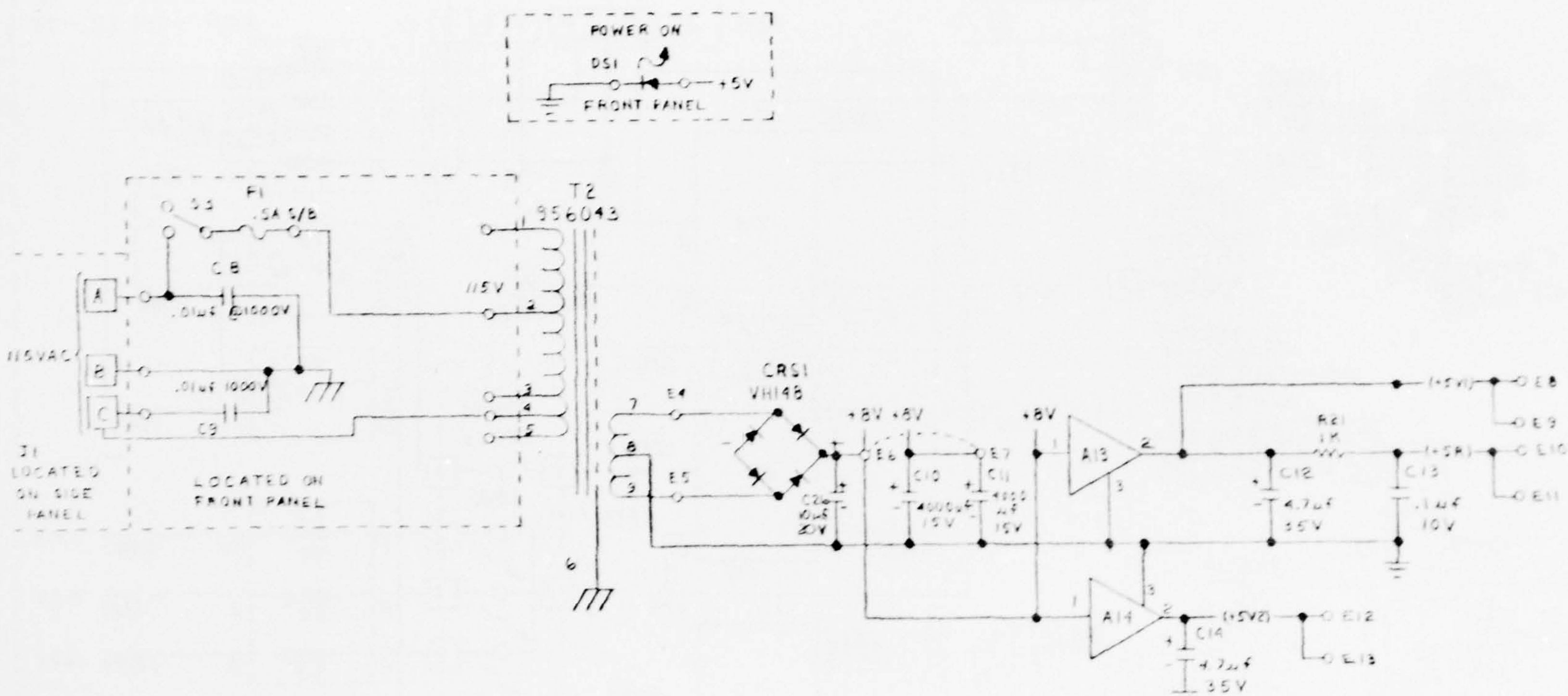


MAJOR COUNTER/COMPARATOR
(UNIT SECOND, TEN SECOND, UNIT MINUTES, TEN MINUTES, UNIT HOURS, SIGN)

Sheet 3 of 5

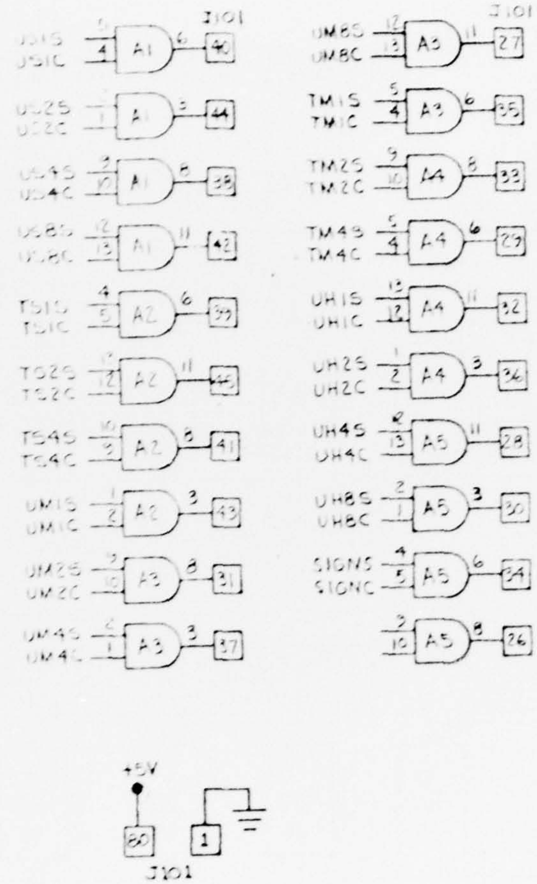

DETECTOR CARD
EVENT INITIATOR SCREEN BOX POWER SUPPLY 4.5V
FRONT PANEL
SIDE PANEL
R1 - R3 1K Ω 1/8W
R4 - R10 330 Ω 1/4W
C1 100µF 12VDC

Sheet 4 of 5



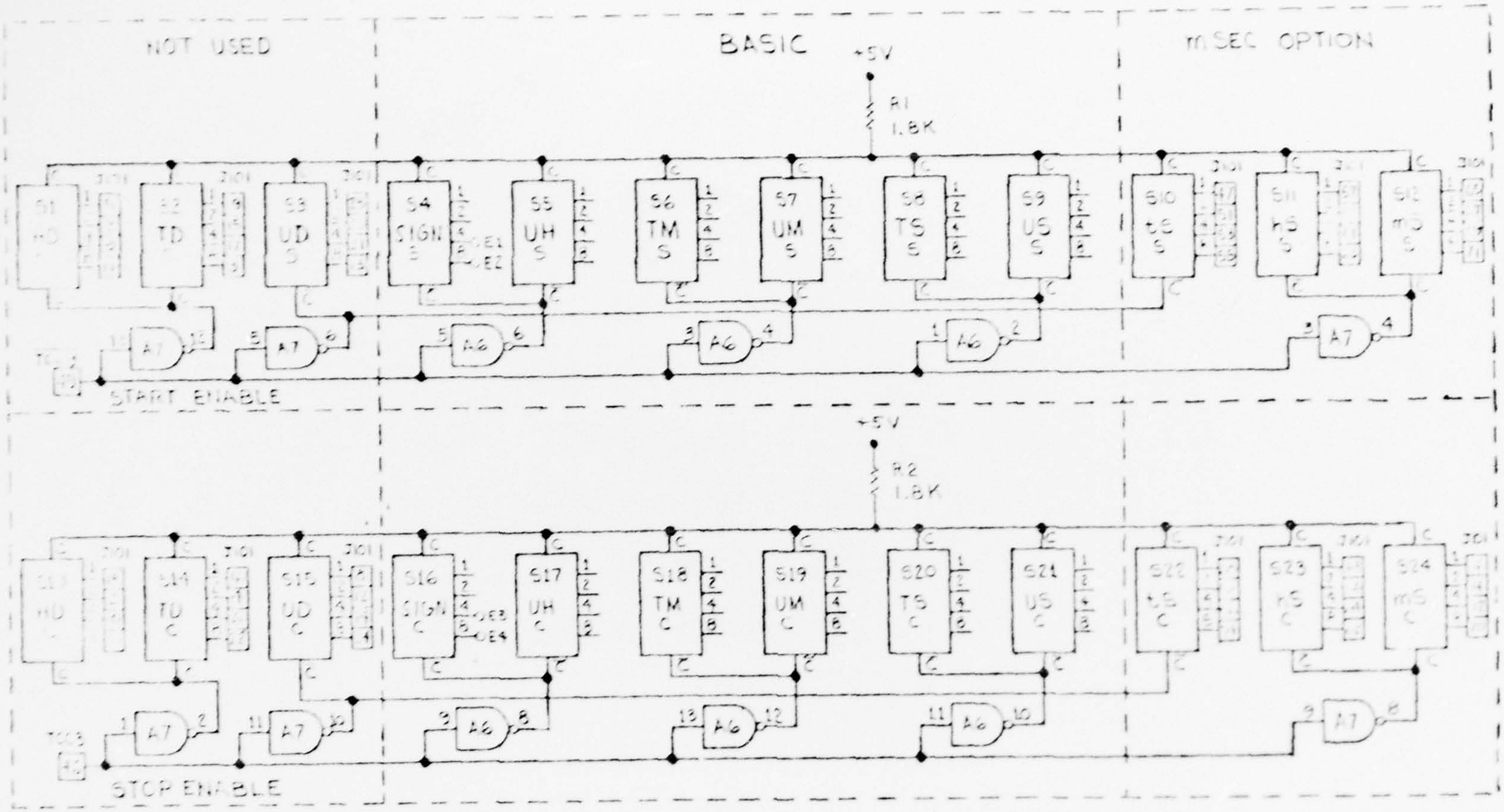
POWER SUPPLY

Sheet 5 of 5



SWITCH CARD
ASSY

Sheet 1 of 2

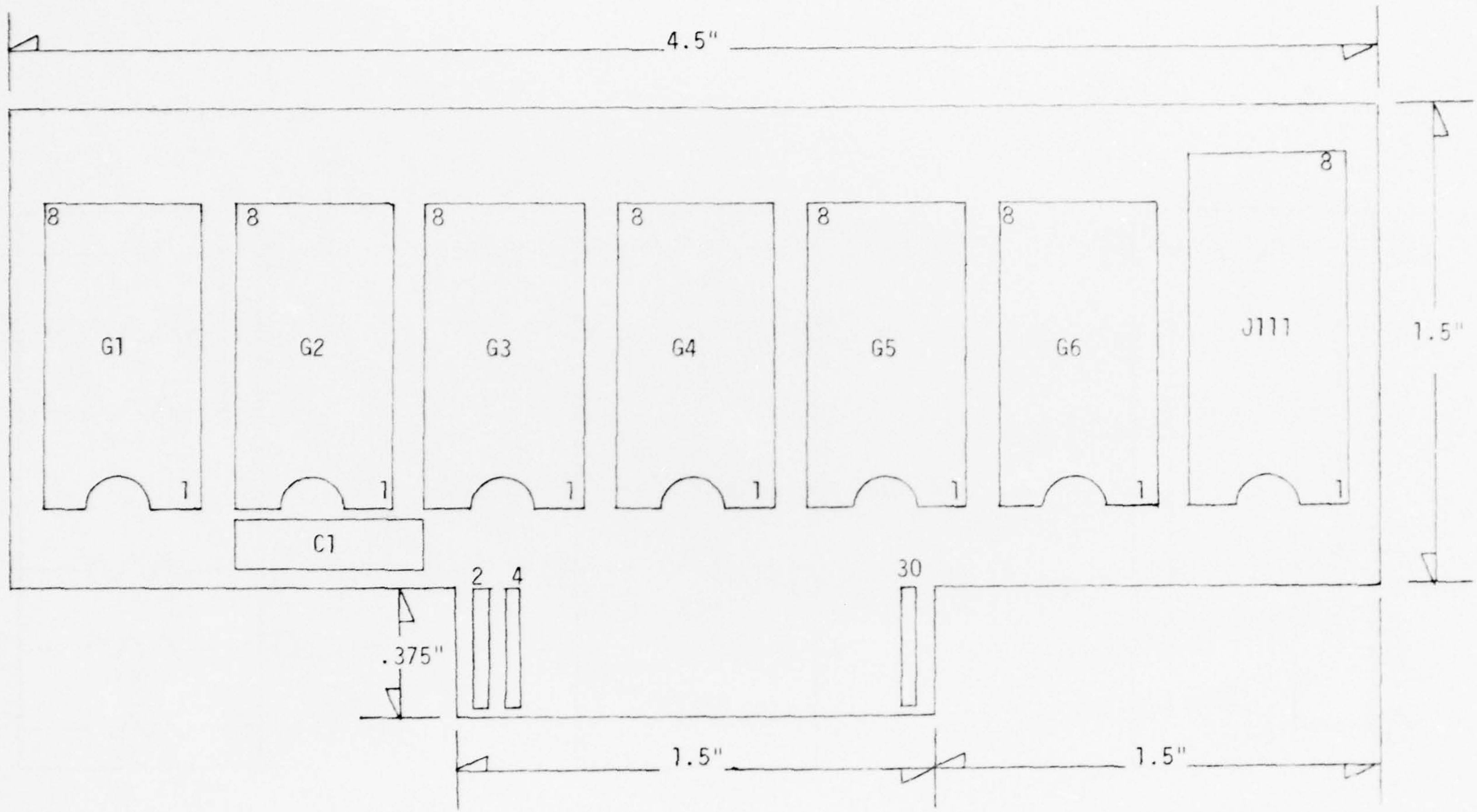


1. SWITCH OUTPUT TERMS ARE LABLED BY THE SW. FUNCTION, S FOR START C FOR STOP. EXAMPLE: HD1S = HUNDRED DAYS, DECODED BCD 1, START TIME

SWITCH CARD ASSY

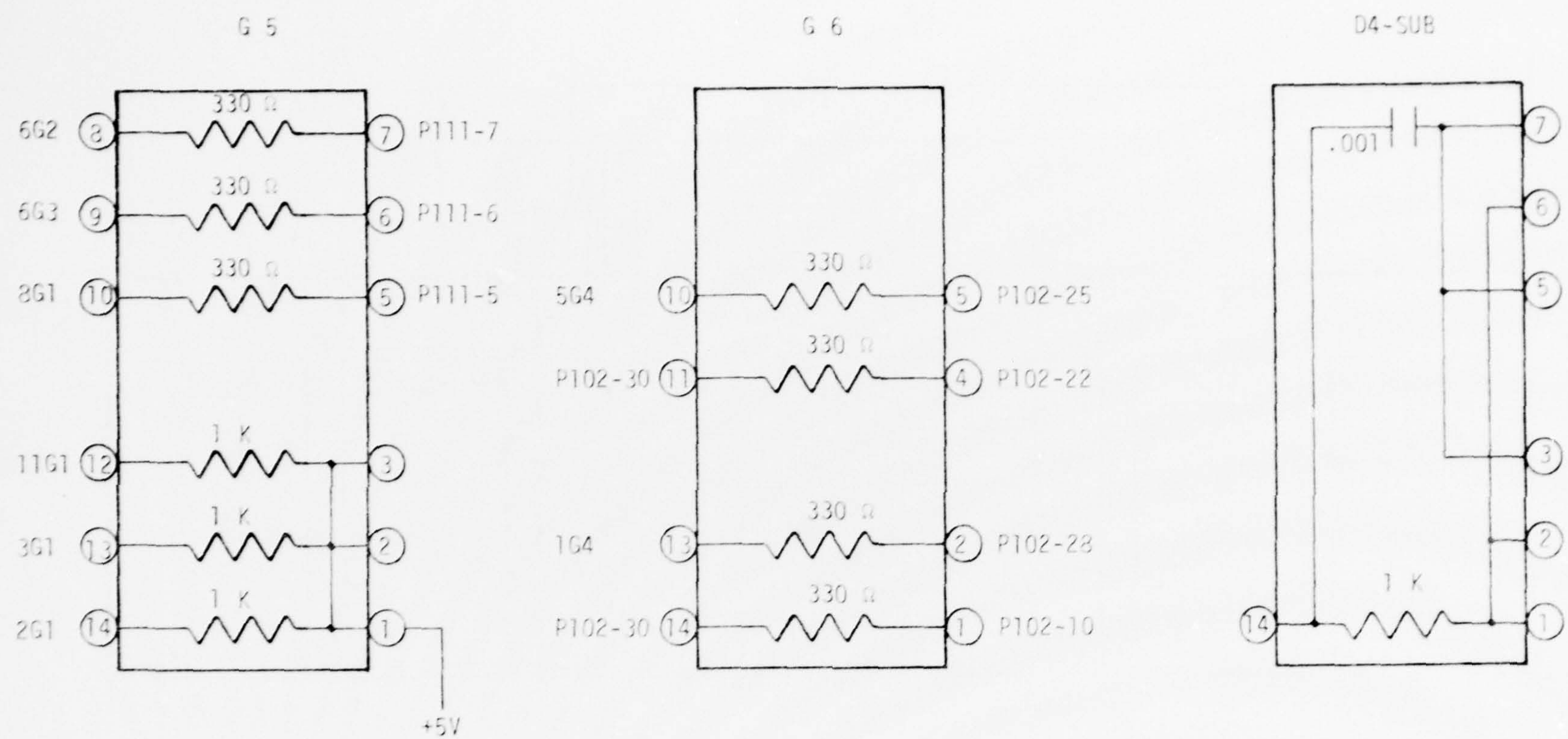
Sheet 2 of 2

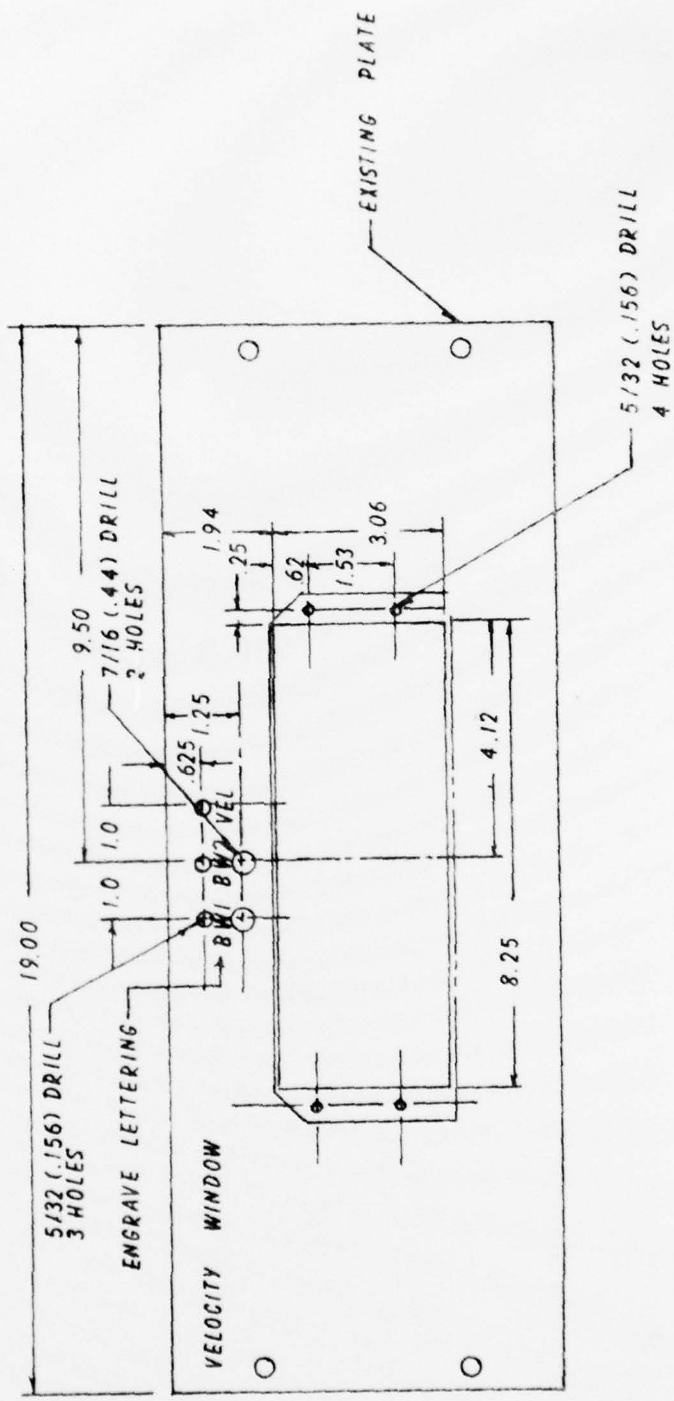
DETECTOR CARD - FRONT VIEW

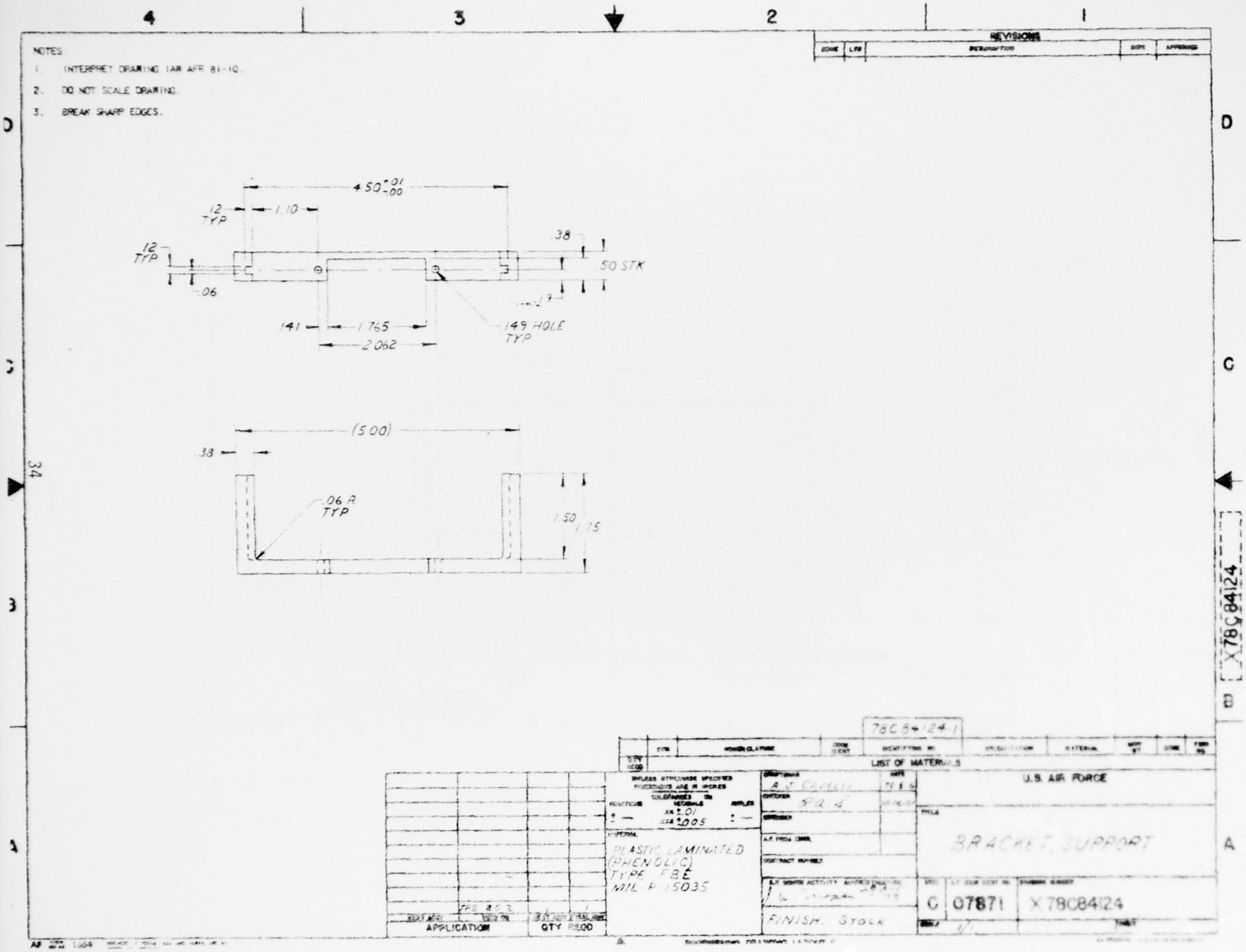


CAMBION WIRE-WRAP CARD, P/N715-1015-01
MODIFIED TO ABOVE DIMENSIONS

ADAPTOR PLUGS




EXISTING PLATE
5/32 (.156) DRILL
4 HOLES
19.00
9.50
7/16 (.44) DRILL
2 HOLES
1.25
.625
1.0
1.0
5/32 (.156) DRILL
3 HOLES
ENGRAVE LETTERING
BW1
BW2
VEL
VELOCITY WINDOW
1.94
.25
.62
1.53
3.06
4.12
8.25



NOTES:
1. INTERPRET DRAWING IAW AFR 81-10.
2. DO NOT SCALE DRAWING.
3. BREAK SHARP EDGES.
REVISIONS
4.50 +.01 -.00
.12 TYP
1.10
.38
.50 STK
.06
.141
1.765
2.062
.149 HOLE TYP
(5.00)
.06 R TYP
1.50
1.75
X78C84124
78C84124-1
LIST OF MATERIALS
U.S. AIR FORCE
PLASTIC LAMINATED (PHENOLIC) TYPE FBE MIL-P-15035
BRACKET, SUPPORT
FINISH: STOCK
C 07871 X78C84124
APPLICATION
QTY REQD

APPENDIX B

DETECTOR CARD WIRE LIST

WIRE LIST FOR
DETECTOR CARD

FROM	TO	SIG
1P102		+5V
2P102		+5V
14P102		Ground
21P102		Ground
3P102	1G3	Reset
4P102	1G2	200KHZ
6P102	2G3	TCC3
7P102	11G2	Zero
8P102	5G3	Vel
10P102	1G6	BW1H
22P102	4G6	BW1H
25P102	5G6	BW1L
28P102	2G6	BW1L
30P102	11G6	+8V
2G1	4G1	5R1
4G1	10G1	5R1
10G1	12G1	5R1
12G1	4G3	5R1
2G1	14G5	5R1
3G1	1J111	BW1S
3G1	13G5	BW1S
1G1	13G1	Reset
5G1	5G2	
6G1	2G2	SWB1
8G1	10G5	LBW2
9G1	3G3	SWB2
11G1	12G5	BW2S
13G1	1G3	Reset
7G1	Ground	Ground
14G1	+5V	+5V
4G2	5G2	
6G2	8G5	LBW1

FROM	TO	SIG
7G2	Ground	Ground
14G2	+5V	+5V
6G3	9G5	Lvel
7G3	Ground	Ground
14G3	+5V	+5V
1G4	13G6	BW1L
2G4	6G4	Ground
6G4	8G4	Ground
8G4	12G4	Ground
12G4	Gnd	Ground
5G4	10G6	BW2L
9G4	4J111	
13G4	3J111	
1G5	2G5	+5V
2G5	3G5	+5V
3G5	+5V	+5V
5G5	7J111	
6G5	6J111	
7G5	5J111	
12G5	2J111	BW2S
14J111	2J102	+5V
3G2	12G2	
12G2	13G2	
14G6	11G6	+8V

APPENDIX C

DETECTOR CARD PARTS LIST

PARTS LIST - DETECTOR CARD

ITEM NO.	STOCK/PART NO.	DESCRIPTION	MFR	UNIT TOTAL	REF NO
1	5999P5008684801	Card, Wire Wrap - General Purpose	Combion	1	
2	500D 100-12DC	Capacitor, 100 µf	Sprague	1	C1
3	5935-00-132-5978	14 Pin, I/C Socket	Vector	6	
4	5935-00-132-5979	16 Pin, I/C Socket	Vector	1	
5	5962-00-865-4625	I/C, 7400	Texas Inst.	1	G2
6	5962-00-106-4289	I/C, 7474	Texas Inst	2	G1, 3
7	4N33	I/C (Optical Isolator)	Monsanto	2	G4
8	5935-00-141-2506	Adapter Plug		2	G5, 6
9	5905-00-114-0710	Resistor, 330 ohm, ½W		7	R4-R10
10	5905-00-617-2610	Resistor, 1K ohm, 1/8W		3	R1-R3

PARTS LIST - D4 SUB

ITEM NO.	STOCK/PART NO.	DESCRIPTION	MFR	UNIT TOTAL	REF NO
1	5935-00-141-2506	Adapter Plug		1	
2	5910-00-893-7428	Capacitor, .001 µf/200VDC		1	
3	5905-00-617-2610	Resistor, 1K ohm, 1/8W		1	

PARTS LIST - VELOCITY WINDOW PANEL

ITEM NO.	STOCK/PART NO.	DESCRIPTION	MFR	UNIT TOTAL
1	5930-00-823-0018	Switch, P.B. (Red)	Alco	1
2	5930-00-687-0710	Switch, P.B. (Blk)	Alco	1
3	5961P4304H1	LED-Red		1
4	5961P4304H5	LED-Green		1
5	5961P4304H7	LED-Amber		1
6	5995P5000014801 P/N CP-16-D-24-S	Cable & Plug Assy		

APPENDIX D

TIMING DIAGRAMS

TIMING DIAGRAM